Too Invested to Change: The Role of Uncertainty Avoidance on Corporate Contribution to Global Warming

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Abstract

Climate change due to the emission of greenhouse gases is a global problem yet there is no consensus on how to resolve this problem. While prior studies have primarily focused on firm-level determinants of greenhouse gas emissions, we explore whether the culture of a firm's host country also influences its propensity to control greenhouse gas emissions. To the extent that uncertainty avoidance reflects societies' adherence to norms and rejection of a change in the social order, firms within societies with higher uncertainty avoidance would assign higher risk premiums to carbon abatement initiatives, resulting in greater emissions. We posit and find a positive association between collective uncertainty avoidance (Hofstede, 1983) and firm-level greenhouse gas (GHG) emissions using a sample of firms across 38 countries. An increase in a country's uncertainty avoidance measure of one standard deviation leads to a firm-level increase in GHGs of approximately 41%. The positive relationship is actuated by a firm's dependency on external funding as well as investment intensity, a country's propensity for economic decline, and the resilience of the social fabric. The findings highlight important policy implications for nations' carbon neutrality objectives.

Keywords: Culture; Uncertainty Avoidance; GHG; Carbon Emission.

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1. Introduction

It is impossible to understate the importance of global warming in today's social discourse. In response to the attention and sense of urgency that the issue generates, much of the scholarship intersecting business policy and corporate environmental performance focuses on the economic payoff of *green* initiatives (e.g., Busch and Lewandowsky, 2017); on negative externalities (Chava 2014; Bolton and Kacperczyk, 2021; Bolton and Kacperczyk, 2020; Seltzer et al., 2020; Ilhan et al., 2021; Huang et al., 2018; Kacperczyk and Peydro 2021); or on financial determinants (e.g., Akey and Appel, 2020; Shive and Forster, 2020; Azar et al., 2021; Ben-David et al., 2018; Naaraayanan et al., 2021; Ilhan et al., 2020). There is mounting evidence of the financial benefits for corporations that mitigate climate change (Griffin et al., 2021; Busch and Lewandowski, 2017; Kim et al., 2021, Chava, 2014), and yet many firms struggle to transition towards sustainable practices.[1] The limitations of extant economic reasoning point towards alternative perspectives, such as national culture, to supplement our understanding of corporate emissions policy. There is a dearth of academic coverage that addresses the influence of national culture upon GHG emissions, as in the recent work of Griffin et al. (2021). We add to the current literature by elucidating how cultural uncertainty avoidance as conceptualized by Hofstede (1983) manifests itself in the context of corporate finance such that it can affect carbon emissions at the firm level.

The adoption of environmentally conscientious technologies and practices is no different from the consideration of any other project available to the firm. Hence, the disposition of a firm's greenhouse gas emissions can be understood, at least in part, as a real option that can be evaluated in the context of capital budgeting. It follows that the discounting factor used to assess the merits of corporate emissions abatement incorporates the perceived risks associated with such a course of action. Cultural norms may find their way into the imputation of risks (Chui, Lloyd, and Kwok, 2002; Shao, Kwok, & Guedhami, 2010; Zheng, El Ghoul, Guedhami, and Kwok, 2012 and Li, Griffin, Yue, and Zhao, 2013 among others). For example, Bakshi et al. (2021) avail themselves of currency option prices to deduce differences in stochastic discount factors between pairs of

[1] See, for example, how European oil firms have fallen behind environmental goals, or how the largest emitting firms are not expected to meet reduction targets on their emissions.

countries. Among those factors that account for the dissimilarity in pricing kernels is the cultural distance between economies. That is, culture influences the present value of a project because deviating from social standards is considered risky by economic agents. Pan et al. (2020) offer support to the notion that cultural values are embedded into corporate policy. The authors present evidence that when a CEOs cultural background favors uncertainty avoidance, acquisitions are more likely to occur among targets in similar industries or with higher synergistic prospects. For Pan et al.'s conclusions to hold water in an economic sense, there must exist a risk premium that compensates an economic agent for the disutility of departing from one's cultural background. Such a premium raises the benchmark at which culturally unsound projects are accepted. We concern ourselves with uncertainty avoidance because it is the cultural dimension that lends itself to interacting with the risk of adapting to climate change.

To motivate the idea that uncertainty avoidance raises the required rate of return on corporate emissions abatement initiatives, it is first necessary to establish how adapting to climate change constitutes a risky departure from the social norm. The theory of social inertia by Bourdieu (1985) postulates that individuals in a society observe a set of behaviors, lifestyles, and habits through their social class, interactions, and networks that they take for granted rather rebel against it. Such social or cultural "habitus" are transmitted from one generation to the next, eventually defining the social order. Often social inertia limits societal adoption of change. Consistent with the theory of social inertia, Brulle and Norgaard (2019) argue that climate change can impose cultural trauma, where society resists change and endures the standing order. We posit that the collective desire for inertia abounds in a culture in which disdain for uncertainty is a social value. Therefore, firms will resist adopting climate mitigation strategies because they represent a departure from societal norms or values. In other words, for a firm to initiate a carbon abatement project in a country with high uncertainty avoidance, it will have to pay an additional risk premium as investors will require incremental compensation for the risk associated with social change. Therein lies the crux of our thesis: uncertainty avoidance delays or altogether negates initiatives to mitigate carbon emissions by raising the bar at which the financial viability of said initiatives is assessed.

The influence of cultural norms, such as uncertainty avoidance, counteract market incentives to abate emissions. Moreover, adopting abatement measures might be costly, risky, or entail a profound shift in decision-making and operations. Hang et al. (2019) argue that the financial short-term payoff for mitigation is immaterial. To the extent that societal norms are centered upon avoiding uncertainty, we would expect lesser carbon abatement initiatives at the firm level as firms in countries with higher uncertainty avoidance most likely pay an additional risk premium to offset the risk of disrupting societal norms. Thus, carbon abatement projects become too costly to adopt under a risk-averse cultural setting. Connecting Hang et al.'s contribution to the practice of capital budgeting for emissions reduction projects implies that a project's most immediate benefits, which are discounted less, are too small to surmount the required payoff necessary for transformation.

We test the notion that uncertainty avoidance increases companies' carbon emissions using a panel of approximately 1,500 firms (over 4,300 observations) representing 38 countries between 2007 and 2018. Consistent with our prediction we find a positive association between uncertainty avoidance and firm's carbon emissions. An increase of one standard deviation in uncertainty avoidance is associated with a corresponding increase of over 40% in firm-level emissions, after controlling for relevant national and company-specific factors. We conduct several robustness tests to check for consistency in our results. First, we include industry-period fixed effects, which account for unobserved time-variant industry heterogeneity. Second, as US firms make up a considerable segment of the sample, we exclude US firms to address any selection bias. Third, we augment our main model with additional country-level measures that can subsume the effect of uncertainty avoidance. Our results remain unchanged throughout all robustness analyses. In recent years several countries have adopted carbon mitigation strategies following the Paris Agreement. As a further robustness check, we examine whether the Paris Agreement has any moderating effect on the positive association between uncertainty avoidance and carbon emissions. We augment the baseline specification with an interaction term that captures the post-Paris Agreement period. We find no significant moderating effect of the Paris Agreement, which suggests that existing multilateral efforts to abate global warming fail to address the cultural connotations that impact corporate decisions. Further, the findings underscore the tension between economic motives and societal practices.

Our findings could suffer from unobserved spurious correlations between uncertainty avoidance and firm-level carbon emissions due to omitted variable bias. Besides, reverse causality can also lead to erroneous inference. To further rule out such endogeneity concerns, we supplement our main analysis through a two-stage least squares procedure in which uncertainty avoidance is instrumented by the genetic distance from the country with the highest aversion to ambiguity, Greece. Our results remain unchanged even after treating the endogenous variable with an instrumental variable, suggesting that there could be a causal relation between uncertainty avoidance and firm's carbon emissions.

Next, we shift our attention to the socio-economic factors that can exacerbate the observed positive association between uncertainty avoidance and firm-level carbon emissions. The first moderating factor we consider is countries' economic condition. Lack of economic opportunities might often result in a lower hurdle rate placed upon abatement initiatives (attributable to uncertainty avoidance). Therefore, firms in countries with declining economic condition would be less inclined to maintain the status-quo and might be more receptive towards initiating risky carbon abatement investments. Guiso et al. (2006) document how cultural values can translate into economic outcomes like national saving, attitudes towards wealth redistribution, and the layout of institutions. It is likely that culture also shapes outlooks towards the risk that technological adaptation to climate change entails. The corporate benefits stemming from emissions abatement cited above, and the political strife caused by climate change (or the perception thereof) point to a social cost that comes with a dearth of action. Said cost would be more affordable and palatable in the presence of economic growth. We conjecture that for uncertainty avoidance to outweigh the financial inducements of GHG reductions, the economic fortunes arising from the reigning social order must be favorable enough to stave off poverty (lest the toll of climate change be compounded with economic instability). Thus, we expect a cross-sectional effect at the country level wherein economic decline lessens the pressure that uncertainty avoidance imparts upon emissions abatement projects. Consistent with our prediction, we find a statistically significant difference between the firms operating in low economic decline countries compared to those in high economic decline settings, suggesting that the influence of risk aversion is not prevalent in countries experiencing economic decline.

Furthermore, corporate environmental policies are set considering the cultural, political, and economic ethos (Markusson et al., 2018). For uncertainty avoidance to drive firm-level emissions, the social fabric must be sound enough to align its constituents with prevailing social values. That is, a lack of social cohesion might fail to reinforce cultural standards, thereby reducing the impact of uncertainty avoidance on firm-level carbon emissions. For example, Cherng et al. (2019) study how social cohesion affects behavior in a way that the spread of disease is minimized. Yet the very norms that preclude illness may be too entrenched to allow for new behaviors to propagate as environmental change brings about novel disease vectors. Cherng et al.'s contribution highlights the importance that the strength of the social fabric has in imparting cultural cues. As such, we expect that the relationship between uncertainty avoidance and firm-level emissions is weaker among distressed societies because the cultural divergence risk premium is not as transmissible among society's members.

Additionally, the theorized relationship is manifested in corporate policy to the extent that a firm engages with financial markets. Absent the incentives from financial markets (e.g., Bolton and Kacperczyk, 2020; Seltzer et al., 2021; Ilhan et al., 2021; Konar and Cohen, 2001), cultural norms like uncertainty avoidance are left unopposed. That is, that the financial benefits of abatement that are conveyed by the markets (e.g., lower cost of capital, higher valuations) are immaterial for a firm that seldom participates in capital markets. Yet a management team operating in a risk-averse cultural context would still impute a risk premium upon projects that require new approaches or technologies. It follows that the influence of societal risk aversion upon emissions reduction initiatives would be weakest in the cross-section of firms that relies heavily upon external financing. Our empirical findings confirm our conjecture, and we find significant difference in the effect of uncertainty avoidance on firm's carbon emissions depending on whether the firms rely on external financing or not.

Finally, we explore the contingency in the uncertainty avoidance-emissions relationship through a firm's investment intensity. Greater capital expenditures exacerbate GHG emissions when there is reluctance towards risk because the perception of risk is magnified (Barr and Glynn, 2004). That is, since change is more likely to be interpreted as a threat rather than an opportunity in the eyes of risk averse economic agents, then the pessimism associated with undertaking emissions reductions is magnified among firms that engage in capital expenditures to an elevated degree. Hence, GHG emissions ought to be greater when a firm that is located in a country with an inclination towards uncertainty avoidance also displays an elevated degree of investment intensity. For the empirical analysis, we partitioned our sample into high and low investment intensities and find stronger effect in the high investment intensity group confirming our conjecture.

To our knowledge, this study is the first attempt to assess the role of a central aspect of culture, uncertainty avoidance, empirically using firm-level data on direct emissions. As such, we contribute to the ongoing argument on the variation of corporate environmental performance. Moreover, this study extends our understanding of the weaknesses of economic theory while emphasizing the relevance of cultural paradigms in that regard. Thus, we document an example of how culture helps determine corporate emissions through capital budgeting decisions. The evidence presented, and unambiguous characterization of the boundary conditions through which uncertainty avoidance affects emissions, bridges the gap between abstract notions of social norms and the methodological assessment of risk through economic logic. In particular, the heterogeneity in firms' dependency on capital markets as well as in the scale of their investment policy are revealing of the risk-aversion premium that is assessed upon emissions abatement. The present study also contributes to the literature that addresses culture as a driver of corporate policy (e.g., Shane, 1995; Frijns et al., 2013; Zhang and Zhou, 2014; Barr and Glynn, 2004; Hwang, 2005; Qu and Yang, 2015). By raising often neglected issues in the conduct of business, the results herein lead to implications for practitioners and policymakers that could aid in the mitigation of global warming. In addition, this study also makes a pivotal contribution to the literature on firms' environmental performance by documenting how a non-economic factor can contribute to firm-level carbon emission decisions. Prior literature show firm's listing status (Shive and Forster, 2020); environmental activism (Naaraayanan et al., 2021); institutional ownership (Azar et al., 2021); environmental regulation (Ben-David et al., 2021); and parent's limited liability (Akey and Appel, 2021) are some of the important determinants of firm-level carbon emissions. In contrast, we argue that firms' carbon emission strategy also depends on the cultural values of the country where they are located.

We also contribute to ongoing discussion in international business and (IB) and international management (IM) literature on the role of national culture and how that affects managerial and organizational choices (Caprar et al., 2015). Prior studies in IB (e.g., Erramilli, 1996; Hennart and Larimo, 1998 and Makino and Neupert, 2000) argue that national culture affect firms' choices about ownership levels and entry modes in global expansions of their businesses.

Our paper also complements studies (e.g., Shane, 1995) that examine how differences in cultural attributes such as uncertainty acceptance affects individuals' choices of innovation related roles in organizations. Shane (1995) documents that individuals from high uncertainty acceptance cultures are more likely to adopt innovation championing roles in organizations and that the uncertainty-accepting societies are more innovative than uncertainty-avoiding societies. We argue that firms located in societies scoring high on uncertainty avoidance measure are less likely to invest in newer technologies that limit their greenhouse gas emissions and find empirical results consistent with this idea.

The remainder of this paper is organized as follows. Section 2 presents a review of the relevant literature and hypothesis formulation. Section 3 describes the data and methods used in the study. Section 4 details the results of the analysis, and section 5 offers concluding remarks.

2. Literature Review & Hypothesis Development

A preponderance of greenhouse gas emissions is the result of business decisions, and as such many researchers have studied the managerial, financial, and operational context in which such emissions occur. For instance, Bose et al. (2021) treat the issue under the domain of mergers and acquisitions, finding that firms with higher emissions are more likely to target foreign rather than domestic companies. Moreover, Bose et al. suggest that a target's location tends to have low GDP or weak environmental standards. Also, there are higher announcement returns when a target's country has relatively lax environmental regulation. A different line of inquiry focuses on the relationship between financial performance and GHG emissions. Busch and Lewandowski (2017) conduct a metanalysis of such literature and conclude that there is an inverse relationship at play (i.e., lower emissions are associated with better financial performance). The authors make an important distinction between relative and absolute emissions, such that relative emissions appear more sensitive to variations in performance.[2]

Other academics have studied how carbon emissions are imputed into risk premiums. Ilhan et al. (2021) find that environmental policy uncertainty affects option pricing in that options that protect against downside tail risk are more expensive for companies with greater emissions.

[2] Absolute emissions are a total measure of carbon-equivalent atmospheric releases, whereas relative emissions express carbon-equivalent production as a share of a firm's economic activity.

Seltzer et al. (2021) present evidence suggesting that high carbon emitters bear a greater default risk premium and higher yield spreads, more so in places with superior environmental enforcement. Attig et al. (2013) associate the sensitivity of credit ratings with firms' corporate social responsibility activities. Bolton and Kacperczyk (2020) document the widespread existence of a carbon emissions equity premium for both direct and indirect discharges. Moreover, the carbon equity premium has increased over time, while institutional investors have divested from high emitters in foreign countries. Azar et al. (2021) investigate the role of institutional ownership and emissions, finding that an increasing stake by BlackRock, Vanguard, and State Street Global Advisors yields lower emissions among high polluters over time. Chava (2014) finds corroborating evidence in terms of higher expected stock returns and loan spreads, as well as lower levels of institutional ownership for firms with exposure to hazardous chemical, emissions, and climate change concerns.

Yet another strand of research examines corporate innovation productivity. Kim et al. (2021) note how exposure to foreign markets with high environmental standards increases patent applications by multinational corporations, resulting in improved firm value in the long run. Furthermore, value creation is mediated by the extent to which the home country generates clean energy, has a developed economy, and an effective government. In addition, the effect is stronger in high-polluting industry sectors (e.g., mining, oil, and energy).

Thus, one can summarize recent scholarly contributions on the ramifications of GHG emissions upon corporate policy as follows. High-emitting firms seek targets where there is less environmental regulation to contend with, and the market rewards such behavior (Bose et al., 2021). Yet there are various economic incentives by which companies could seek to become *greener*. First, financial performance improves as a firm's relative emissions decrease (Busch and Lewandowski, 2017). Second, the markets incorporate the cost of GHG's as high emitters face a greater cost of capital (Seltzer et al., 2021; Bolton and Kacperczyk, 2020; Chava, 2014; Attig et al., 2013), and the cost of insurance in the form of options is greater for such companies (Ilhan et al., 2021). Third, competing in a foreign economy with enhanced environmental regulation improves firm value by fostering innovation for the parent company (Kim et al., 2021). Fourth, institutional investors prefer holding assets from environmentally conscientious firms (Azar et al., 2021; Chava, 2014). In the face of such market-driven incentives it is compelling to wonder why firms would pollute at all. Undoubtedly, there must be competing economic carrots, institutional disincentives to mitigation, and overarching cultural paradigms obstructing reductions in carbon emissions.

Colgan et al. (2011) offer an insightful take framed upon political economy. The authors theorize that the institutional framework related to climate change is the result of a dynamic political and economic process in which opposing camps reassess the value of their assets as the planet becomes warmer. On one side, there are those whose assets exacerbate climate change in exchange for lucrative rents (e.g., carbon-based energy producers), and on the opposing side are those whose assets are exposed to climate risk (e.g., stakeholders of coastal properties). As climate change and mitigation efforts play out, the values of all assets change, along with the structure of political bases and the incumbents they sustain. Colgan et al. expect domestic and international political realignment that is likely to impact trade and economic integration policy. Although we are amenable to such views, we contend that additional nuance is needed to understand corporate GHG emissions, particularly along a cultural vector.

2.1. Capital budgeting and carbon emissions

There is evidence that managers think of their firms' GHG emissions in the context of capital budgeting decisions. For example, Byrd et al. (2020) note how firms in carbon-intensive industries that have imposed an internal carbon pricing mechanism tend to have fewer emissions. Yet there are contradictory accounts (e.g., Moya et al., 2011; Meyar and Kiymaz, 2015) which claim that no consideration is given to emissions in the practice of capital budgeting. The controversy may be due to such a premium being contextual. Considering the disposition of financial markets towards emissions, it is a stretch to believe that executives would ignore such clear signals at the expense of a higher cost of capital.

For GHG emissions to feature in a firm's discounting factor, there must be considerations that are specific to that subset of the market. That is, there must be variation in the set of risk factors priced by investors. Bakshi et al. (2021) present evidence that the heterogeneity in stochastic discount factors between countries is in part accounted for by cultural differences. Juxtaposing Byrd et al.'s (2020) findings that are specific to a few industries with Bakshi et al.'s contribution, it appears that firms in certain cultural settings might be more prone to address emissions mitigation under a strategic asset allocation perspective. Moreover, when the cultural ethos shuns uncertainty, the implementation of technologies that would curb emissions would be assessed harshly. In sum, we propose that abating climate change requires significant investments, and corporations gauge the feasibility of such investments through the lens of capital budgeting. Furthermore, cultural paradigms may lead to a greater required rate of return for firms that embark in emissions reduction initiatives.

a. The necessity to consider the role of culture on carbon emissions

Already several authors have asserted a connection between cultural as well as sociological issues and carbon emissions. Brulle and Norgaard (2019) posit that the risk of cultural trauma (i.e., the systematic disruption of the cultural basis of a social order) drives social inertia to restore the status quo at individual, institutional, and societal levels. Thus, inertia in the face of cultural trauma caused by global warming is a social control mechanism within a rational framework. Burton and Farstad (2019) provide a vivid example of the degree to which culture affects GHG emissions. The authors document how, among dairy farmers in Norway, parenting, recreational, and spousal role expectations lead to higher emissions through the increased purchase of milking robots. Glaringly absent from Burton and Farstad's takeaway is the profit motive.

Markusson et al. (2018) lay a sophisticated theoretical foundation that highlights the shortcomings of a uniquely market-driven approach at understanding the variation in firm-level emissions. The authors consider the tradeoff between negative emission technologies (NETs), such as carbon capture in the form of geoengineering, and emissions mitigation. In essence, overestimating the future efficacy of NETs has resulted in the delay of mitigation initiatives. Such a delay is consistent with Brulle and Norgaard's (2019) stance on cultural trauma. To make sense of the postponement of mitigation activities, Markusson et al. propose three paradigms: realist, cultural, and cultural-political-economic (CPE).

The realist interpretation, much in line with economic reasoning (e.g., Busch and Lewandowski, 2017; Colgan et al., 2011; Kim et al., 2021, etc.) zeroes in on individualist agency, neoliberalist tenets (i.e., the market's ability to efficiently price risk), and managerial agency. The realist view is versatile enough to account for cognitive biases, such as those resulting from the oversimplification or lack of understanding of NETs. However, the realist paradigm alone cannot explain corporate reticence towards emissions reduction. For instance, there are those economic incentives cited earlier that somehow fail to induce mitigation. On the other hand, there is evidence noted earlier suggesting that factors beyond material interests influence how businesses address climate change. Markusson et al.'s poignant indictment of the realist explanation is that it misses the impact of social norming, institutions, cultural narratives, and power relations. Furthermore, the authors argue that when individual agency is limited by a lack of understanding of the issue at hand, a collectivist account is of greater value. Under such a premise, even an aggregate analysis at the market level is inadequate because of the inherent assumption that decisions by economic agents are made by autonomous individuals while dismissing the influence of cultural norms and the unequal distribution of political power.

The cultural paradigm is characterized by the interaction between technology and culture but fails to account for the political and economic context in which corporate policy is set. In the cultural domain, framing (i.e., the tacit context in which an idea is presented) becomes relevant. According to Markusson et al., framing of NETs draws from science, engineering, and economics, but ignores sociological issues, particularly power dynamics. Hence, the authors suggest a paradigm that considers economic incentives, social framings as well as imaginaries, and shifts in political power to explain delays in mitigation activities.[3] The CPE view builds upon the cultural interpretation but incorporates political regime change driven by economic blocks and social values. Thus, mitigation delay becomes a function of material interests and dominant social views. Firms are induced to emit more carbon so long as they stand to gain from it and have the political power to make it so. The shortcomings of the market-driven explanation in terms of carbon emissions, as well as Brulle et al. (2019) and Markusson et al.'s (2018) contributions impel us to seek answers in the cultural domain.

b. Cultural dimensions and carbon emissions

Inquiries based on cultural dimensions have been applied to economics, finance, accounting, management, and other areas of business research in many forms. Hofstede's (1983) and Schwartz's (1999) cultural dimensions are the standard for such literature. For example, An et al. (2018) encounter evidence that stocks in countries with high individualism have a greater propensity to crash. Gouveia and Ros (2000) find that individualism and power distance are related to a country's wealth and level of education. Han et al. (2010) conclude that uncertainty avoidance

[3] An imaginary is a sociological term. According to the ESRC STEPS Centre, "an imaginary describes the visions, symbols, and associated feelings that people have about something."

has a negative relationship with earnings management, while individualism has a positive relationship. Also, the influence of either cultural factor upon earnings management is mediated by the degree of investor protection. Shao et al. (2010) show evidence that conservatism and mastery help explain dividend policy. Shao et al.'s contribution is yet another example of how cultural considerations extend our understanding of corporate policy beyond that which is predicated by economic theory.

Closer to the topic at hand is the work from Griffin et al. (2021), who posit that individualism is positively associated with firm-level environmental and social performance through country- and firm-level channels. Specifically, freedom of the press and protection of equal rights facilitate said relationship at the country level, while managerial discretion, board diversity, and corporate transparency operate at the firm level. Like Bush and Lewandowski (2017), Griffin et al. conclude that there is a positive link between environmental and social performance and firm value.

Of particular concern for us is the role of Hofstede's (2011) uncertainty avoidance, which is defined as a society's tolerance for ambiguity. Note that uncertainty avoidance in the cultural sense is not the same as an individual's reluctance to engage in risk. Rather, uncertainty avoidance is a latent factor brought forth by a compilation of social values, such as derision towards ambiguity and a collective desire to minimize uncertainty. It is the combination of such social values that partially color a person's desire for risk. Barr and Glynn (2004) demonstrate how uncertainty avoidance accounts for the variation in perceptions of controllability (the labeling of a situation as a threat or opportunity). The authors also show how the notion of lack of control is an effective discriminant for threat determination. Barr and Glynn's results imply that decision-making in high uncertainty avoidance settings is distinctive from other scenarios and prone to eagerly deem a situation a hazard. Moreover, uncertainty avoidance is a pervasive, fundamental attribute of a society. For instance, Kashima and Kashima (1998) show evidence of how countries with languages that allow pronouns to be dropped and those with multiple second-person pronouns exhibit higher scores in Hofstede's uncertainty avoidance scale. Such findings are linked to the stress component of the uncertainty avoidance construct, as speakers of said languages face constant decisional stress in their discourse and social interaction.

Theoretically, uncertainty avoidance is a likely driver of GHG emissions because it fits with Brulle and Norgaard's (2019) social inertia model and Markusson et al.'s (2018) CPE paradigm. That is, the disruption of the social order would bear greater importance in a culture that rues opacity and that offers an institutional framework that deters emissions mitigation. There is evidence of the connection between inertia and risk tolerance in other domains. Frijns et al. (2013) note that executives located in countries with low risk tolerance (i.e., high risk aversion) require better synergies before engaging in corporate takeovers.

c. Uncertainty avoidance and carbon emissions

We are hardly the first to address uncertainty avoidance as it pertains to carbon emissions. Disli et al. (2016) link the Environmental Kuznets Curve (the concave relationship between economic activity and carbon emissions) to several dimensions of culture. The authors find that uncertainty avoidance shifts the curve depicting said relationship downwards, thus lowering emissions at any level of economic activity. Crucially, uncertainty avoidance shifts the curve's inflection point such that the turning point at which emissions decline occurs at a much greater level of economic output. The trajectory of the curve's inflection point under increasing uncertainty avoidance is noteworthy because it implies stagnation of environmentally friendly policy at a national level.

Another instance of uncertainty avoidance in the environmental scholarly realm comes from Peng and Lin's (2009) work. The authors study how social and institutional capacity for environmental sustainability (SIC) is positively linked to uncertainty avoidance. However, we differ with Peng and Lin's interpretation of the findings that environmental performance is positively related to uncertainty avoidance for several reasons. First, the capacity for environmental sustainability is not necessarily the same as environmental performance. At best, such capacity is an indirect measure, and at worst a spurious insinuation, of environmental performance. Second, there may be endogeneity between SIC and uncertainty avoidance. Indeed, societies with high uncertainty avoidance deride vagueness and would thusly forge robust institutions and an adaptable social order. Yet, the second-order connection between uncertainty avoidance and actual environmental performance could be associated with omitted variables. Our critique of Peng and Lin suggests that a direct measure of carbon emissions is preferable, and that endogeneity should be empirically addressed.

An additional contribution linking uncertainty avoidance to GHG emissions comes from Slawinski et al. (2017). The authors propose a theoretical framework in which short-termism (i.e., undervaluing outcomes in the future) and uncertainty avoidance reinforce each other at individual, organizational, and institutional levels to limit absolute reductions in carbon emissions.[4] The association between uncertainty avoidance and short-termism is through temporal uncertainty. We take heed of Slawinski et al.'s contribution as an endorsement to pursue uncertainty avoidance as a driver for CO_2 emissions. However, our conceptual approach is not necessarily the same as that of the authors, as we do not endeavor to specify the cultural impediment to emissions abatement. Instead, we advocate for a steep opportunity cost to change that may also be consistent with Brulle and Norgaard (2019), Markusson et al. (2018), and Colgan et al. (2011). That is, the collective inclination towards uncertainty avoidance places a higher required rate of return on mitigation projects because of an aversion to temporal uncertainty (Slawinski et al., 2017), or due to an attempt to salvage the status quo through inertia (Brulle and Norgaard, 2019), or following cultural-political-economic considerations (Markusson et al., 2018; Colgan et al., 2011).

Yet another relevant work is that of Vastola et al. (2017), who study how culture influences the relationship between corporate environmental and financial performance.[5] Vastola et al.'s study is analogous to Disli et al.'s (2016), which was undertaken at the national level, and complementary to Busch and Lewandowski's (2017) summation of the financial-environmental performance literature. Vastola et al. note how financial performance in terms of firm value, return on assets, and return on equity, is worse for firms in high uncertainty avoidance venues that emit fewer GHG's. Given such results, the authors propose that uncertainty avoidance leads to innovation inertia and lower levels of environmental performance, noting that "a cultural context denoted by reticence to risk could turn into… a partial commitment to innovation, as in the case of environmental management." Such findings lead the authors to hypothesize that uncertainty avoidance reduces the payoff for environmentally friendly strategies. Like Slawinski et al. (2017), Vastola et al. analyze absolute emissions. The implications from Vastola et al. and Slawinski et

[4] We take note that Slawinski et al. (2017) deems relative reductions of GHG emissions to be insufficient at addressing climate change.
[5] Vastola et al. (2016) and Markusson et al. (2018) appear to share our view that economic theory does not tell the whole story behind carbon emissions.

al. highlight the need to empirically assess how uncertainty avoidance could affect absolute carbon emissions.

While several contributions, such as Slawinski et al. (2017) and Disli et al. (2016), urge a theoretical association between uncertainty avoidance and environmental performance, there is a dearth of empirical analysis to validate such a relationship. To our knowledge, we are the first scholarly attempt to present direct, firm-level evidence of how cultural uncertainty avoidance would result in greater carbon emissions.

d. Hypothesis Development

We subscribe to the notion that global warming itself, or the socio-political upheaval associated with it, endangers the status quo. Furthermore, we adhere to Brulle and Norgaard's (2019) proposition of social inertia in response to cultural trauma. Critically, addressing climate change requires adopting new technologies and reconsidering economic models, which require new, risky investments on the part of corporations. Hence, societies in which there is a high degree of uncertainty avoidance would harbor those firms that are most reluctant to mitigate carbon emissions because they would discount the benefits of such initiatives more aggressively. Disli et al.'s (2016) finding that societies with high uncertainty avoidance decrease their emissions only at a much greater level of economic output is an important, yet suggestive finding supporting the theorized relationship between uncertainty avoidance and CO_2 emissions; one that merits further examination at the firm level. Vastola et al. (2016) note how firms in a cultural environment characterized by a disdain for risk find little financial incentive to curb emissions. Therefore, we expect there to be a positive relationship between uncertainty avoidance and direct, firm-level, absolute GHG emissions.

H1: Uncertainty avoidance is positively associated with firm-level carbon emissions.

We propose that the mechanism by which uncertainty avoidance affects firm-level emissions is in the form of an expensive opportunity cost (i.e., discounting factor) assessed against the benefits related to the change required to abate global warming. Analogous to the results from Frijns et al. (2013), firms in a culture disinclined towards risk would ascribe a greater required rate of return for green initiatives in compensation for upending the status quo. Colgan et al. (2021) allude to a dynamic pricing process by which to reflect exposure to climate change. Ilhan et al.

(2021), Seltzer et al. (2021), Chava (2014), and Bolton and Kacperczyk (2020) present evidence of how such a risk is imputed in various financial markets. The toll that uncertainty avoidance places upon mitigation by way of said opportunity cost is subject to the firm's systemic and idiosyncratic exposure to global warming.

In terms of the firm's systemic exposure to climate change, we hypothesize that the hurdle rate placed upon abatement initiatives (that is attributable to uncertainty avoidance) declines under deteriorating economic conditions. That is because, regardless of the disposition of the firm's assets with respect to climate change exposure, the present values of expected future cash flows are universally lessened at lower levels of future economic activity. As the present value of assets falls under an economic downturn, there is less of an incentive to preserve the status quo and more impetus behind adopting new, risky initiatives. Hence, we propose that economic decline ameliorates the link between uncertainty avoidance and carbon emissions.

H2: The relationship between uncertainty avoidance and GHG emissions is weakened by worsening economic activity

Regarding a firm's idiosyncratic exposure to global warming, we maintain that the impact of uncertainty avoidance on emissions is regulated by the firm's reliance on external financial resources. The results from Chava (2014), Bolton and Kacperczyk (2020), and Seltzer et al. (2021) indicate that external financing is costlier for companies with higher carbon emissions. In the absence of external financing, there is no corrective action from the markets to instigate curbing emissions. Moreover, ownership by major institutional investors tends to wane corporate emissions (Azar et al., 2021). Without such incentives, risk aversion takes an even greater hold of managerial decisions regarding CO_2 emissions. Therefore, we hypothesize that the direct relationship between uncertainty avoidance and emissions is greater when a firm has a relatively lower dependence on external financing.

H3: The relationship between uncertainty avoidance and GHG emissions is stronger when a firm is less reliant on external financing.

We concur with Markusson et al. (2018) that corporate policy pertaining to the state of the environment is set in the context of economic, cultural, and political considerations. It follows that, for Markusson et al.'s CPE paradigm to affect such policy, there must be a social order in place that is robust enough to reinforce the collective values and materialistic interests of various groups. Alternatively, the lack of social cohesion would render inert the influence of uncertainty avoidance upon firm-level GHG emissions. Davis et al. (2019) identifies a link between perceived cultural decline and economic anxiety as they study the rise of anti-immigrant sentiment in democratic societies. Eckersley (1996) argues that cultural decay, which is manifested in the incidence of suicide, depression, crime, obsessive dieting, and consumption of illicit drugs, is a result of weakening social values that give people a sense of belonging and meaning. Crucially, Turchin (2013) develops a model by which to quantify political distress such that it is a function of demographic pressures, the dynamics of the upper class, and the stability of the state apparatus. Turchin contends that "the effects of demographic processes on political instability are channeled through social structures." The model proposed by the author effectively predicts the outbreak of political violence in England and the United States. In essence, we expect that the vulnerability of the social order moderates the proposed relationship between uncertainty avoidance and firm GHG emissions under Markusson et al.'s CPE paradigm. That is, that the state of the social order is a channel for the relationship between uncertainty avoidance and CO_2 emissions.

H4: The relationship between uncertainty avoidance and carbon emissions is weaker among firms in distressed societies.

Barr and Glynn (2004) make an important contribution by recognizing how uncertainty avoidance guides how situations are viewed by decision makers, as either an opportunity or a threat. The authors also cite corroborating evidence from other studies suggesting that uncertainty avoidance increases the likelihood of interpreting a scenario as a threat. The result is relevant to this study because of how uncertainty avoidance might tinge investments that enhance environmental performance. We hypothesize that the greater the investment intensity of a firm, the higher its emissions if the cultural framework favors surety. Managers who view abatement as a threat because of their cultural background will opt for technologies and methods that are familiar to them.

H5: The relationship between uncertainty avoidance and GHG emissions is stronger among firms with high investment intensity.

3. Data & Methodology

3.1. Sample

The sample for our main set of results consists of an unbalanced panel of 1,145 firms between 2007 and 2018, resulting in 4,351 firm-year observations. Firm-level GHG emissions are sourced from the non-profit CDP.[6] Firm characteristics are gathered from Compustat, except for the number of segments, which is sourced from CDP. Country-level factors have been accessed through the World Bank,[7] with the exception of the globalization measure, which comes from the KOF Swiss Economic Institute.[8] Economic projections are operationalized by the Economic Decline and Poverty index (EDP)[9], as compiled by The Fund for Peace. The Fund for Peace's Fragile States index[10] (FSI) has been adopted as a proxy for social vulnerability. A firm's dependency upon external financing is observed through the Kaplan-Zingales (KZ) index (Kaplan and Zingales, 1995). All variables have been winsorized at the extreme 1% of their distributions, annually. Financial values have been converted to 2007 constant U.S. dollars, as in Griffin et al. (2021), to account for the effects of exchange rate and inflation drift in the analysis. The appendix lists the variables used throughout the study, their definitions, and sources.

a. Empirical Model and Variable Definitions

We utilize a fixed effects estimation of firm-level GHG emissions to ascertain the conditional impact of uncertainty avoidance. Following Griffin et al. (2021), the specification addresses omitted variable bias by incorporating year and industry fixed effects. For the same reason, we employ standard errors clustered at the firm level. As such, the regression of GHG emissions for the i^{th} firm in country j, industry k, at year t is as follows:

[6] See at www.cdp.net/en
[7] See at https://data.worldbank.org/
[8] See at https://fragilestatesindex.org/indicators/e1/
[9] See at https://fragilestatesindex.org/indicators/e1/
[10] https://fragilestatesindex.org/methodology/

$$
\begin{aligned}
&Emissions_{i,j,k,t} \\
&\quad = \beta_0 + \beta_1 Uncertainty\ avoidance_j + \beta_2 Size_{i,t} + \beta_3 BM_{i,t} + \beta_4 ROE_{i,t} \\
&\quad + \beta_5 Leverage_{i,t} + \beta_6 Investment_{i,t} + \beta_7 PPE_{i,t} + \beta_8 Diversification_{i,t} \\
&\quad + \beta_9 FDI_{j,t} + \beta_{10} GDP\ Growth_{j,t} + \beta_{11} Globalization_{j,t} \\
&\quad + \beta_{12} Government\ effectiveness_{j,t} + \sum_k \beta_k \mathbb{I}_k + \sum_t \beta_t \mathbb{I}_t + \varepsilon_{i,j,k,t}
\end{aligned}
$$

The coefficient of interest in terms of H1 is β_1, which we surmise to be positive if said hypothesis is to be supported by the data. The β_k and β_t are the coefficients for industry and year fixed effects, respectively.

The dependent variable in our study is the logarithmic form of a firm's scope 1 global gross emissions for a year.[11] Following Slawinski et al. (2017) and Vastola et al. (2017), we focus on a firm's absolute emissions under the premise that relative emissions may not be enough to deter global warming.

We posit that the prevalence of uncertainty avoidance in a society affects corporate decisions on GHG emissions by raising the benchmark (discounting factor) at which the necessary change to undergo mitigation activities becomes financially desirable. Said benchmark can be viewed as an opportunity cost, and its effects ought to be moderated by prospects of economic activity, a firm's dependence on external financing, investment intensity, and the health of the social order. Thus, the independent variable in the study is a country's uncertainty avoidance (Hofstede, 1983). Unlike the other variables in the study, uncertainty avoidance lacks within group and temporal variation. Clearly there cannot be within group variation for uncertainty avoidance as the construct varies between countries and the panel estimator is set to contrast firms. The absence of temporal variation is consistent with Beugelskijk et al. (2015), who find that the cultural distances between countries are stable over time, drifting in absolute but not in relative terms. Thus, while there is ample variability in terms of uncertainty avoidance between countries, the relative cultural differences themselves have not meaningfully changed over time.

[11] The U.S. Environmental Protection Agency defines scope 1 emissions as those GHG emissions "that occur from sources controlled or owned by an organization."

The controls used in the analysis of firm-level GHG emissions follow Bolton and Kacperczyk (2020) and Griffin et al. (2021). At the firm level, we account for the scale of a firm's operations (i.e., size according to its market capitalization), its growth potential as conveyed by the book-to-market ratio, financial performance (i.e., return on equity), debt-to-assets ratio, investment intensity (capital expenditures per assets), fixed assets (i.e., property, plant, and equipment), and its scope based on the number of segments in which it operates. At the country level, we control for the value of foreign direct investment inflows as a share of GDP (FDI), GDP growth, inclination towards globalization (Savina et al., 2019; Dreher, 2006), and government effectiveness.

We carry out a series of tests to ensure that the results presented herein are not spurious. First, a different fixed effects layout is implemented, wherein industry categories are interacted with years. Second, we take precaution in the empirics with regards to the composition of the sample. A substantial portion of firm-years come from the United States, and as such we might be capturing an effect in our regressions that is more an indicator for location rather than the proposed relationship. To address such a concern, we implement the main specification while removing firms from the United States, expecting the sign of uncertainty avoidance to remain unchanged. Third, the main specification is expanded to rule out alternative explanations for the relationship between uncertainty avoidance and emissions. Although the presence of additional controls is not theoretically necessary, the inclusion of factors dealing with a country's economic, institutional, and technological features assures that said relationship is unbiased. Therefore, an additional control for a country's economic development is proxied by de Hass and Popov's (2019) financial development measure, which the authors link to per capita emissions at the country level. A relationship between institutional quality and economic development (e.g., Henisz, 2000) could also explain emissions, as uncertainty avoidance is known to partially determine the institutional environment (Alesina and Giuliano, 2015). We use the Heritage Foundation's[12] Property Rights index to summarize the status of a country's institutions, as in Claessens and Laeven (2003). Returning to the notion of the Environmental Kuznets Curve, it possible that a country's economic development could be manifested in terms of technological development (e.g., Roller and

[12] See at https://www.heritage.org/index/about

Waverman, 2001). Thus, we control from the share of the population with access to the internet in the expanded specification. Such a figure is attained from the World Bank.

The signing of the Paris Agreement is the latest framework through which the international community seeks to address climate change. The treaty may be construed as the most prominent multilateral response to global warming. According to Savaresi (2016), the Paris Agreement shifts from targets and timeframes to commitments on emissions reduction and transparency in reporting mitigation efforts. In addition, the treaty brings forth adaptation to climate change by means of sharing financial and technological resources, acknowledges issues of climate change justice, and recognizes the role of non-governmental actors. Comprehensive as the Paris Agreement might be, there are no stipulations that would address how national culture may affect emissions. Therefore, the conditional relationship between uncertainty avoidance and emissions portrayed in this work is likely robust to the treaty's signing.

One issue that could undermine the results herein is that of endogeneity. The fixed effects and clustered standard errors employed in the main specification address omitted variable bias to some extent. In addition, a two-stage least squares (2SLS) regression of emissions is implemented, using genetic distance from Greece as the instrument for uncertainty avoidance. Harrati (2014) explores the genetic antecedents of risk aversion by leveraging the U.S. Health and Retirement Study. The author notes how studies conducted upon twins point towards risk aversion being an inherited trait. Thus, Harrati endeavors to identify the genetic markers that connote tolerance for risk. Crucially, the findings imply that risk aversion is polygenic (i.e., expressed through multiple gene traits). Zyphur et al. (2009) study the extent to which economic risk preferences could be explained by genetic factors among twins, concluding that over half of the variation is attributable to an individual's genomic disposition. As risk aversion is an inherited trait passed on by a highly diffused set of genes, we contend that genetic distance from the country that exhibits the highest degree of uncertainty avoidance is theoretically a viable instrument for said variable. The conceptual validity of the proposed instrument is complemented empirically by the first-stage results displayed below, thereby meeting the relevance requirement necessary for a suitable instrument. Furthermore, there is a dearth of scholarly literature, and no obvious theoretical connection, by which genetic distance from Greece could be related to firm-level GHG emissions other than through uncertainty avoidance. Thus, we argue that the candidate instrument fulfills the exclusion criterion that is essential for the procedure at hand. The data pertaining to a country's Genetic distance from Greece comes from the replication data for Spolaore and Wacziarg (2009), which is available through the Harvard Dataverse (2017).

The assessment of the boundary conditions described above is made through seemingly unrelated regression systems. A proxy for each contingency is identified and the data is divided into high and low subsamples relative to the annual median for the adequate proxy. Then, a chi-squared statistic compares the magnitude of the β_1 coefficient between subsamples. Thus, a country's economic prospects are captured through the EDP index, which aggregates several measures of current and forward-looking economic activity. Examples of elements that go into the EDP index are the level of government indebtedness, projected GDP, level of consumer confidence, and reliance on a single commodity. The KZ index operationalizes a firm's reliance on capital markets. Said index considers a company's internal financing (i.e., cash flows), external financing (market capitalization and debt), and cash management policy (dividends as well as cash equivalents) to arrive at a relative measure of the need to access financial markets to sustain operations. The higher the KZ index, the greater the reliance on access to external financing. The FSI is a comprehensive measure of the wellbeing of a country across four vectors of social pressure: cohesion, economic, political, and social. In turn, each of the FSI's subscales is composed of several factors associated with it. For example, the social indicator for vulnerability examines the demographic pressures that a country is facing, while the political vector accounts for factors such as state legitimacy as well as human rights and the rule of law. Investment intensity is observed through a firm's ratio of capital expenditures to assets.

b. Descriptive Statistics and Univariate Correlations

There are 38 countries represented in the data, with most firm-years coming from the United States (33% of the sample). The firms in the sample correspond to 65 industries, based on two-digit Standard Industry Classification codes. The industry with the most observations is Chemicals and Allied Products, accounting for 13% of the data. On average, Russian firms emit the most GHGs during the period.[13] The industry with the highest average emissions per company during the sample period is petroleum refining and related industries. Tables 1 and 2 list each of

[13] We take note that Russia ranks sixth in total GHG emissions during the same period according to Climate Watch.

the countries and industries represented in the study, respectively. Given the variety of nations and sectors in the data, it is reasonable to conclude that the findings herein describe a general effect with broad implications.

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Insert Table 1 around here

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Insert Table 2 around here

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Summary statistics for the dependent and independent variables in the study, as well as their covariates, are found in Table 3. Panels A and B summarize the distributions and covariances of firm-level variables, respectively. Panels C and D similarly address country-level characteristics. At first glance, Panel B implies that firms' GHG emissions are increasing in companies' size, leverage, capital investments, fixed assets, and scope. Also, emissions seem inversely related to profitability and its growth prospects, which is consistent with Busch and Lewandowski (2017) and Kim et al. (2021), respectively. The positive correlation between leverage and emissions is unanticipated, considering the work of Seltzer et al. (2021). Yet the reader must be mindful that correlational evidence is suggestive and requires multivariate testing to gauge its veracity. In terms of the correlation between emissions and leverage, it may be the case that firms with more fixed assets and capital expenditures, which emit more carbon, need to borrow more to fund their operations. At the national level, Panel D suggests that countries that are more risk averse tend to have slower economic growth, fewer inflows of foreign direct investment, and be less inclined towards global integration.

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Insert Table 3 around here

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The first channel raised in the study (i.e., H2) pertains to a country's expected economic activity. Such a notion is captured through the EDP index. The Philippines bears the highest average economic decline scores in our sample, while Canada the lowest.

A firm's KZ index value is observed by applying the coefficients in Table 9 of Lamont et al. (2001). On average, firms in the Engineering, Accounting, Research, Management, and Related Services exhibit the most reliance on external funding, while those in Tobacco Products the least. Australian firms tend to rely the most on external financing, while South Korean firms display the lowest KZ scores.

Yet another channel considered is one that describes the vitality of the social fabric (H4). The economic decline index utilized to test H2 is but one component of the economic indicator of social health, along with uneven economic development as well as human flight and brain drain. In general, Turkey has the highest FSI scores, and Finland the lowest.

The last channel explored is through a firm's investment intensity (H5). Such a construct is operationalized through the ratio of capital expenditures to assets. The industry with the highest degree of investment intensity in the sample is Automotive Repair, Services, and Parking. The country with the highest average investment intensity for the period is Malaysia, while the lowest corresponds to the Philippines.

4. **Results**

The findings pertaining to the tests for H1 can be found in Table 4. Column 1 shows a specification that only includes uncertainty avoidance and fixed effects. Column 2 incorporates firm-level control variables, while column 3 adds country-level covariates. The findings in column 4 display the full model specification as discussed above. Across all specifications, the coefficient of uncertainty avoidance is positive and significant. In the main specification (column 4), uncertainty avoidance is directly related to firm-level GHG emissions, $b = 0.02$, $t = 4.12$, $p < 0.001$. Such a regression accounts for 46% of the within-groups variance observed in GHG emissions, $F = 57.94$, $p < 0.001$. Therefore, we conclude that H1 is supported by the data. That is, firms in a country characterized by cultural risk aversion tend to expel more GHG's into the atmosphere.

Column 4 suggests that an increase of one standard deviation in the uncertainty avoidance scale bears a 40.70% increase in GHGs among constituent firms.[14]

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Insert Table 4 around here

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The signs of control variables in Table 4 allow us to expound upon certain notable associations with carbon emissions. Several firm-level characteristics are consistent predictors of emissions. Particularly, highly diversified firms and those with more fixed assets tend to emit more GHG's. While the coefficient for fixed assets is unsurprising (b = 0.98, t = 18.84, $p < 0.001$), the one for a firm's number of segments (b = 0.53, t = 3.29, $p < 0.01$) is intriguing. The direction of the relationship between a firm's scope and emissions is indicative of the difficulty in adopting mitigation activities when its operations encompass a variety of offerings. Another reliable firm-level predictor is return on equity, which bears a negative sign, b = -0.00, t = -3.36, $p < 0.001$. The direction of such a relationship is reminiscent of Busch and Lewandoski's (2017) contribution. Firm size (i.e., the logarithm of a company's market capitalization) shows a (counterintuitive) inverse relationship with the dependent variable, b = -0.09, t = -6.09, $p < 0.001$. One way to interpret the influence of size upon emissions is to analogize Disli et al.'s (2016) finding of a concave relationship between national income and emissions. There may be a similar effect at work at the firm level, such that larger (i.e., more valuable) firms adopt mitigation at a higher level for various reasons. At the national level, an internationalist inclination implies fewer emissions for constituent firms, b = -4.24, t = -4.33, $p < 0.001$. One explanation for such a result follows Kim et al. (2021), in that exposure to foreign markets with better environmental standards drives innovation and firm value. Thus, companies in a globalized setting may have additional incentives to mitigate emissions. Lastly, an examination of the r-square coefficients across models suggests that most of the variance in firm-level CO_2 emissions is accounted for by firms', rather than national, characteristics.

a. Robustness Checking

[14] $100 \times (e^{0.016 \times 21.341} - 1) \approx 40.699$

The first robustness test implemented is with regards to the choice in fixed effects. The variation in the dependent variable may be better captured by industry-year fixed effects rather than by industry and year dummies. Column 1 in Table 5 checks the consistency of the uncertainty avoidance coefficient vis-à-vis Table 4 under an alternative fixed effects scheme. Therefore, while in Table 4 there are 12 and 59 dummies for years and industry categories, respectively, the industry-year approach includes 402 fixed effects. The uncertainty avoidance coefficient is qualitatively the same as in column 4 of Table 4, suggesting that the main finding in this paper is robust to a stricter specification in terms of fixed effects. There is a minute increase in the coefficient's effect size compared to that of Table 4, column 4, such that an increase of one standard deviation in uncertainty avoidance implies an increase in emissions of 44%. Incidentally, the interacted effects afford a small improvement in predictive power, as the r-squared becomes 46.6% (compared to 45.9% in column 4, Table 4).

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Insert Table 5 here

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Another worry is that the plurality of firm-years from U.S. firms could be biasing the results. Since uncertainty avoidance (in a cultural sense) varies across countries and not firms, it may be that the effect expressed through the corresponding coefficient in the regressions of firms' GHG emissions is really a reflection of being a U.S. company. In column 2 of Table 5 we exclude U.S. firms from the sample and implement the same specification by which other results have been observed. The coefficient for uncertainty avoidance, $b = 0.01$, $t = 3.46$, $p < 0.01$, is qualitatively similar to those in Table 4, and suggests an increase of 38% in emissions given an increase of one standard deviation in the uncertainty avoidance scale. Therefore, we conclude that the relationship documented in this study is not merely a proxy for national designation.

By including additional variables, it is possible to reduce the likelihood that the proposed relationship is due to other explanations. In column 3 of Table 5, the standard specification is augmented with national measures for financial development, property rights, and access to the internet. Such factors can help rule out economic, institutional, and technological explanations. Indeed, the uncertainty avoidance coefficient is relatively unchanged in the implementation of the more expansive regression, $b = 0.020$, $t = 2.95$, $p < 0.01$. The expanded specification suggests that an increase of one standard deviation in uncertainty avoidance would lead to an increase in GHGs of 53%. Interestingly, there is evidence that countries that are more financially developed (i.e., that have a greater capitalization of their private credit and stock markets) have lower emissions. Such a result is further validation that financial markets impart better environmental performance, and that a connection to them, as asserted in H3 results in lower emissions.

Column 4 in Table 5 presents the results of our primary specification with the addition of an interaction term between uncertainty avoidance and an indicator for years after Paris Agreement was signed.[15] The significance of the interaction term, $b = -0.00$, $t = -0.76$, $p > 0.10$, is well above any conventional benchmark. That is, the impact of uncertainty avoidance on emissions is no different after 2015. A joint hypothesis test of the coefficients for uncertainty avoidance under the new specification reveals that said variable continues to account for a significant share of the variation in firm-level emissions, $F = 14.94$, $p < 0.001$. The estimation in column 4 implies an increase of 38% in emissions conditional on an increase in uncertainty avoidance of one standard deviation. Consistent with the results throughout the analysis, the partial effect of uncertainty avoidance in such a regression is positive.[16] In sum, the positive effect that uncertainty avoidance has on firm-level emissions is unaffected by the signing of the Paris Agreement. Such a result is consistent with our expectation that the Paris Agreement, which operates on an economic and technological framework, does not affect emissions incentivized through a cultural paradigm. Furthermore, the result is an endorsement of Markusson et al.'s proposition that emissions must be accounted for through a combination of cultural, political, and economic theories. The robustness of the main result to the signing of the Paris Agreement reveals the tension between economic motives and societal practices.

b. Instrumental Variable Approach

Out of concern for endogeneity, we also conduct an instrumental variables procedure in which we use genetic distance from Greece as an instrument for uncertainty avoidance. The results of the 2SLS regressions are found in columns 1 and 2 of Table 6. Column 1 pertains to the first stage of the procedure, in which the significance of the coefficient of genetic distance from Greece

[15] The main effect of the post-Paris Agreement indicator is subsumed by the year dummies in the regression.
[16] $0.017 – 0.002 = 0.015$.

implies that, empirically, the instrument meets the relevance criterion in the presence of the covariates from the main specification, b = 0.03, t = 15.17, $p < 0.001$. In column 2, the instrumented version of the independent variable is positive and significant in a regression of emissions, b = 0.03, t = 3.89, $p < 0.001$. The findings from the 2SLS procedure imply a causal effect on the part of cultural uncertainty avoidance towards firm-level GHG emissions. Furthermore, the consistency in uncertainty avoidance coefficients between those in Table 4 and that of the instrumented variable in column 2 suggests that the conditional effect of uncertainty avoidance is adequately depicted in a properly specified fixed effects estimator.

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Insert Table 6

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c. Boundary conditions for the relationship between firms' GHG emissions and uncertainty avoidance

We test the proposed channels discussed above (hypotheses 2, 3, 4, and 5) by means of seemingly unrelated regression procedures. The sample is partitioned into high and low subsets based on the annual median for the economic decline index, Kaplan-Zingales index, fragile states index, and investment intensity. Then, we run the main specification displayed above in each subsample and compare the magnitude of the ensuing uncertainty avoidance coefficients.

For H2 to be supported by the data, the magnitude the uncertainty avoidance coefficient in the low EDP index subsample ought to be significantly larger than that of the high EDP subsample. The findings related to the economic outlook channel (H2) are found in panel A of Table 7. There is no evidence of the effect of uncertainty avoidance on GHG emissions among firms in countries with an unfavorable economic outlook, b = 0.00, z = 0.03, $p > 0.10$. Yet, in firms located within countries with a low EDP index score, said relationship is palpable, b = 0.02, z = 2.90, $p < 0.01$. A comparison of the magnitude of the coefficients suggests that the difference in effects between high and low EDP subsamples is substantial, $\chi^2 = 4.90$, $p < 0.05$. As the influence of risk aversion is absent in countries that find themselves in economic decline, we find that H2 is supported. In sum, the obstacle that uncertainty avoidance places upon mitigation of emissions is less onerous for countries drifting towards poverty because attachment to the status quo is not compelling under a dynamic pricing model à la Colgan et al. (2021).

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Insert Table 7 around here

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Firms that emit more GHG's face a higher cost of capital by paying higher interest on debt (Seltzer et al., 2021) and carrying a greater equity premium (Bolton and Kacperczyk, 2020). As such, high-emitting firms are subject to market signals that penalize carbon emissions. Hypothesis 3 conjectures that there ought to be a reduction in emissions for firms that rely on financial markets. Thus, H3 is validated if the magnitude of the uncertainty avoidance coefficient is greater in the low KZ index group than that which is observed among firms with a high KZ index score. We substantiate said notion through the evidence in display in Table 7, panel B, in which we compare uncertainty avoidance coefficients from the regression of firm GHG emissions between groups given a benchmark in the KZ index. Uncertainty avoidance is positively related to firm emissions in both the high ($b = 0.2$, $t = 4.11$, $p < 0.001$) and low ($b = 0.13$, $t = 3.75$, $p < 0.001$) groups with respect to the KZ index. However, the effect is much greater among firms that do not depend on external financing, $\chi^2 = 10.63$, $p < 0.01$. It is evident that firms that emphasize internal sources of funding lack an incentive to reduce emissions. We thus consider H3 to be validated by the data. Furthermore, the cross-sectional evidence pertaining to reliance on capital markets is a strong indication that our proposition holds. That is, companies that access financial markets more often are more exposed to a carbon-related cost of capital, such that the effect of uncertainty avoidance recedes. The sensitivity of emissions to financial markets strongly suggests that environmental performance is treated as a capital budgeting choice. In addition, the result is consistent with Bakshi et al.'s (2021) findings on the informative power of cultural heterogeneity upon stochastic discount factors between economies.

A natural extension of Markusson et al.'s. (2018) CTE paradigm is that if the social fabric is not strong enough to reinforce cultural standards, the impact of collective risk aversion must be lessened. In H4 we postulate that for uncertainty avoidance to affect carbon emissions there must be a common set of values by which shared norms frame social issues. Our expectation regarding H4 is to find a larger effect for firms in the low FSI subset. The findings in panel C of Table 7 show how the effect is nonexistent among firms in dystopian societies, $b = -0.01$, $t = -0.75$, $p > 0.10$. On the other hand, uncertainty avoidance is a driver of GHG emissions for firms with lower values of the FSI, $b = 0.02$, $t = 2.90$, $p < 0.01$. We encounter sufficient evidence to ascertain that the uncertainty avoidance coefficients are distinct between subsets in terms of state fragility, $\chi^2 = 4.90$, $p < 0.05$. Thus, we affirm H4 based on the available evidence.

A situation is more likely to be deemed a threat in countries with high uncertainty avoidance scores (Barr and Glynn, 2004). We postulate that firms in risk averse settings with high investment intensity (i.e., a high rate of capital expenditures relative to assets) are reluctant to engage in abatement practices because they view the shift as a threat. Therefore, new investments that would yield better environmental performance are subjected to a higher discounting factor, while familiar, less environmentally conscientious investments enjoy a lower hurdle rate. The findings in panel D of Table 7 concur with H5. In either the high, $b = 0.02$, $t = 4.57$, $p < 0.001$, or low, $b = 0.01$, $t = 2.42$, $p < 0.05$, subset of investment intensity, emissions are positively related to uncertainty avoidance. However, the effect is much stronger in the high investment subset, $\chi^2 = 2.88$, $p < 0.10$. The heterogeneity of effects based on capital expenditures is important because it alleviates the controversy on whether capital budgeting plays a role in corporate emissions. Not only does this paper cement the notion that the use of capital budgeting to affect emissions is situational, but it also establishes a cultural vector by which such decisions are affected.

5. Conclusion

Global warming brings about ecological, political, and economic upheaval. One response to the cultural trauma that follows climate change is to avoid doing much about the crisis (Brulle and Norgaard, 2019). Forestalling abatement is an attempt to exert social control to preserve a status quo. We posit that in a society that recoils from ambivalence and mistrusts the unknown, social inertia in the face of climate change is an even more enticing way to address the issue. When dealing with the risks of climate change, businesses weigh their options given economic incentives, political considerations, and cultural cues (Markusson et al., 2018). At the firm level, the incentive to preserve the status quo given its cultural, economic, and political considerations translates into a higher required return on investments that avert carbon emissions when society prizes risk aversion. Corporations are financially encouraged to expend fewer GHG's by paying less to raise capital (Seltzer et al., 2021; Bolton and Kacperczyk, 2020) and enjoying greater valuations (Busch and Lewandowski, 2017; Kim et al., 2021). However, prevailing social values could cause firms to delay mitigation efforts (Vastola et al., 2017).

It is in the balance of economic incentives and societal norms that lies the impetus for exploring the role of national culture on firm's carbon emissions. If a country's culture favors risk aversion over economic gains, then businesses will follow suit by placing a greater required rate of return for enacting the change needed to stall global warming. We examine an unbalanced panel of firms from 38 countries between 2007 and 2018 to ascertain whether Hofstede's (2011, 1983) uncertainty avoidance measure could explain emissions. Indeed, our results suggest that, after controlling for firm and national characteristics as well as unobserved industry and temporal factors, the degree of a nation's cultural inclination towards uncertainty avoidance drives firms to emit more GHG's. Such a result is validated by a two-stage least squares procedure in which the instrument is based on a country's genetic distance from the most risk-averse nation. Moreover, said finding is robust to alternative specifications, the exclusion of U.S. firms, which make a sizeable portion of the sample, as well as the signing of the Paris Agreement.

We theorize four conditions that enable collective uncertainty avoidance to cause firms to emit more GHG's: the status quo must remain economically appealing, companies must rely on external financing, the social fabric must be resilient enough to sustain cultural dispositions, and the firm must be highly engaged in investing activity. Colgan et al. (2021) proposes a framework in which stakeholders reassess the value of their assets given climate change. We expound upon such an idea by proposing that social inertia as a response to global warming becomes less desirable under declining economic conditions. Under such circumstances, the unknown may not be as unpalatable as a social setting that is conducive to poverty. We find support for the economic decline channel by separating the sample using the Fund for Peace's Economic Decline and Poverty index into firms in countries with a high and low likelihood of economic deterioration. A comparison of uncertainty avoidance coefficients (in the regression of firm GHG emissions) between subsets yields results that align with our proposition. The effect of uncertainty avoidance on firms' GHG emissions is undetectable for those companies located in countries with high EDP index values and is evident otherwise.

The works of Azar et al. (2021), Seltzer et al. (2021), and Bolton and Kacperczyk (2020) suggest that a firm's dependence on external financing allows market forces to moderate corporate environmental performance. We therefore speculate that exposure to financial markets may be enough for the economic incentives of GHG mitigation to overwhelm the cultural influence of uncertainty avoidance. Employing the Kaplan-Zingales (1995) index to segment the sample based on firms' reliance on financial markets allows us to substantiate the external funding channel. Even though there is evidence of a relationship between uncertainty avoidance and firm-level emissions in both subsamples, the effect is significantly greater among companies with greater dependence on internal funding. Such a result alludes to a contextual premium that raises the bar at which abatement initiatives are considered financially feasible. The context itself is whether a firm is influenced enough by market signals to reduce emissions. Otherwise, a social tendency to avert uncertainty results in a risk premium that is imputed upon emissions reduction investments.

The dystopic channel is a corollary to Markusson et al.'s (2018) contribution. We assert that for uncertainty avoidance to influence decisions on corporate emissions, the social fabric must be able to reinforce cultural tenets. A comparison of uncertainty avoidance coefficients from a regression of corporate emissions between groups based on their score in the Fragile States Index lends credence to the viability of the dystopic channel. Uncertainty avoidance as a progenitor of corporate emissions is verifiable among firms located in stable countries, while the effect is untraceable for firms in countries under social duress. Barr and Glynn (2004) conclude that situations are more likely to be labeled as threats in countries with high uncertainty avoidance. We apply such a result to the analysis at hand by suggesting that firms with intensive investment activity located in risk averse countries emit more GHGs. The investment intensity channel is substantiated by the data, wherein the effect of uncertainty avoidance is much larger among firms with high capital expenditures relative to assets.

The analysis is revealing of other notable associations with firm emissions. First, it appears that firm characteristics outweigh the influence of national factors. Second, emissions are increasing in terms of the company's scope (i.e., the number of segments it competes in) and the value of property, plant, and equipment that it possesses. Also, emissions are inversely related to return on equity and size (i.e., natural logarithm of market capitalization). Third, a country's integration with the international community improves companies' environmental performance.

The findings from this study bear several implications. Our work adds to our understanding of how culture affects corporate decisions in general (e.g., Shao et al., 2010), and specifically GHG emissions (e.g., Griffin et al., 2021). Additionally, we contribute to the ongoing scholarly debate on why firms are reluctant to engage in emissions mitigation despite market incentives (e.g., Markusson et al., 2018). For practitioners in matters of corporate environmental performance, our results bring attention to cultural issues that are otherwise neglected and highlight unspoken societal prompts that might be difficult for outsiders to grasp. Whereas conventional thinking in business management would call to attention the economic implications (i.e., profit and loss) of GHG mitigation, we invite practitioners to first contextualize the issue as a contest between financial incentives and social norms in cultural settings where risk aversion is highly regarded. Another result with profound ramifications is the moderating influence of participation in financial markets. Since valuations are better, cost of capital is cheaper, and institutional investors prefer low-emitting firms, market discipline seems like an underused avenue to curb emissions. Reliance on external funding has proven compelling enough to overcome the uncertainty avoidance premium that deters corporate action on GHG emissions. A challenge for policymakers then is to find ways to replicate the right set of incentives for firms that do not need external capital or those in a setting where capital markets are too fragmented to effectively combat climate change. The resilience of the key finding to the implementation of the Paris Agreement should be concerning for policymakers, since abatement initiatives are approached in terms of economic, political, technological, and institutional considerations, without regard for cultural sensibilities. How does one legislate upon cultural norms in a multilateral framework? Perhaps raising awareness of collective dispositions towards the perceived risks of going *green* could be the start of a more conscientious, fruitful engagement as the world strives with the consequences of global warming.

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Appendix: Variables in the study

Variable	Type	Description	Sources
Emissions	Regressand	Natural logarithm of a one plus a firm's total global gross scope 1 emissions.	Carbon Disclosure Project: Home - CDP.
Uncertainty avoidance	Regressor	Hofstede's (2011) scale measuring a country's tolerance for ambiguity.	The dimension scores in the Hofstede model of national culture can be downloaded here (geerthofstede.com).
Size	Covariate	Natural logarithm of one plus the capitalization of a firm's equity.	The Center for Research in Security Prices. Compustat and Compustat Global.
Book-to-market	Covariate	Ratio of a firm's book value of equity to its market capitalization.	The Center for Research in Security Prices. Compustat and Compustat Global.
Return on equity	Covariate	Ratio of a firm's net income to the book value of equity.	Compustat and Compustat Global.
Leverage	Covariate	Ratio of a firm's book values of total labilities to total assets.	Compustat and Compustat Global.
Investment	Covariate/Cross-sectional vector	Ratio of a firm's book values of capital expenditures to total assets.	Compustat and Compustat Global.
Property, Plant, and Equipment	Covariate	Natural logarithm of one plus the book value of a firm's property, plant, and equipment.	Compustat and Commpustat Global.
Diversification	Covariate	Natural logarithm of one plus the number of industry sectors in which a firm participates.	Carbon Disclosure Project: Home - CDP.
Foreign Direct Investment	Covariate	A country's share of net foreign direct investment inflows as a share of GDP.	The World Bank: World Bank Open Data | Data.
GDP Growth	Covariate	Annual growth rate in the market price of a country's aggregate production.	The World Bank: World Bank Open Data | Data.
Globalization	Covariate	An index measuring a country's inclination towards globalization as quantified through a principal component of economic, social, and political attributes.	KOF Swiss Economic Institute: KOF Globalisation Index – KOF Swiss Economic Institute | ETH Zurich.
Government Effectiveness	Covariate	An index measuring perceptions of the quality of public and civil services, policy formulation and implementation, and governmental credibility.	The World Bank's Worldwide Governance Indicators: WGI 2022 Interactive > Documentation (worldbank.org).

Variable	Type	Description	Sources
Financial Development	Covariate	The sum of a country's domestic credit to its private sector as a share of GDP and the market value of stocks traded as a share of GDP.	The World Bank: World Bank Open Data | Data.
Property Rights	Covariate	An index measuring the extent to which a country's laws allows for the acquisition and use of private property.	The Heritage Foundation: 2022 Index of Economic Freedom | The Heritage Foundation.
Internet Users	Covariate	The share of a country's population with access to the internet.	The World Bank: World Bank Open Data | Data.
Genetic distance from Greece	Instrument for uncertainty avoidance	The difference in allele frequencies between a country's population and that of Greece.	Replication data of Spolaore and Wacziarg (2009) available through the Harvard Dataverse: Harvard Dataverse.
Economic Decline	Cross-sectional vector	An index measuring the likelihood of ensuing poverty and diminished economic activity.	The Fund of Peace's Fragile States Index: Fragile States Index | The Fund for Peace.
External Financing	Cross-sectional vector	A measure of a firm's reliance on external financing.	The Center for Research in Security Prices. Compustat and Compustat Global.
Societal Stability	Cross-sectional vector	A broad index measuring the risks and vulnerabilities of a country's social order.	The Fund of Peace's Fragile States Index: Fragile States Index | The Fund for Peace.

Table 1

Observations by country

This table lists the countries that make up the sample for analysis. The mean emissions column conveys the average logarithm of total scope 1 emissions globally for firms within a country.

Country	Observations	Mean emissions
Australia	92	11.72
Austria	38	12.29
Belgium	41	10.03
Brazil	76	11.82
Canada	8	11.66
Switzerland	102	7.91
Chile	8	13.69
China	2	12.60
Colombia	8	13.41
Germany	187	11.99
Denmark	71	8.12
Spain	132	11.75
Finland	127	9.97
France	234	10.82
United Kingdom	93	9.19
Greece	2	9.98
Hong Kong	8	11.44
Hungary	8	10.07
India	88	11.90
Ireland	29	7.54
Israel	8	14.17
Italy	83	12.22
Japan	978	11.59
South Korea	46	11.50
Luxemburg	7	13.03
Mexico	9	12.48
Malaysia	1	6.20
Netherlands	74	9.52
Norway	99	9.34
New Zealand	20	10.10
Philippines	5	12.18
Portugal	34	12.87
Russia	6	16.03
Singapore	6	9.25
Sweden	163	7.72
Thailand	13	13.42
Turkey	21	11.43
United States	1,429	11.36

Table 2

Observations by Industries

This table lists the industries included in the study. The mean emissions column conveys the average logarithm of total scope 1 emissions globally for firms within an industry

Two-digit SIC code	Industry	Observations	Mean emissions
9	Fishing, hunting, and trapping	1	9.49
10	Metal mining	23	14.14
12	Bituminous coal and lignite mining	1	15.79
13	Oil and gas extraction	82	12.87
14	Mining and quarrying of nonmetallic minerals	10	15.43
15	Building construction general contractors and operative builders	81	10.94
16	Heavy construction other than building construction	61	11.04
17	Construction special trade contractors	4	6.74
20	Food and kindred products	298	11.31
21	Tobacco products	2	2.61
22	Textile mill products	10	11.38
23	Apparel and other finished products made from fabrics and similar materials	27	9.71
24	Lumber and wood products, except furniture	24	8.47
25	Furniture and fixtures	11	10.50
26	Paper and allied products	119	12.42
27	Printing, publishing, and allied industries	40	9.38
28	Chemicals and allied products	557	11.83
29	Petroleum refining and related industries	41	15.98
30	Rubber and miscellaneous plastics products	103	9.42
31	Leather and leather products	14	7.60
32	Stone, clay, glass, and concrete products	70	13.71
33	Primary metal industries	91	13.50
34	Fabricated metal products, except machinery and transportation equipment	75	9.68
35	Industrial and commercial machinery and computer equipment	312	9.70
36	Electronic and other electrical equipment	299	10.05
37	Transportation equipment	206	11.62
38	Measuring, analyzing, and controlling instruments; photographic, medical, and optical goods, watches, and clocks	198	9.06
39	Miscellaneous manufacturing industries	30	8.68
40	Railroad transportation	16	14.55
41	Local suburban transit and interurban highway passenger transportation	7	11.95
42	Motor freight transportation and warehousing	30	13.26
44	Water transportation	31	8.19
45	Transportation by air	73	13.98
47	Transportation services	45	10.20
48	Communications	131	10.07
49	Electric, gas, and sanitary services	298	15.26
50	Wholesale trade	34	9.78
51	Wholesale trade – nondurable goods	42	11.86

Two-digit SIC code	Industry	Observations	Mean emissions
52	Building materials, hardware, garden supply, and mobile home dealers	17	12.68
53	General merchandise stores	50	11.39
54	Food stores	41	12.00
55	Automotive dealers and gasoline service stations	3	6.75
56	Apparel and accessory stores	40	8.28
57	Home, furniture, furnishings, and equipment stores	13	10.61
58	Eating and drinking places	18	10.45
59	Miscellaneous retail	33	9.10
60	Depository institutions	46	10.35
61	Non-depository credit institutions	15	9.13
62	Security and commodity brokers, dealers, exchanges, and services	50	7.71
63	Insurance carriers	49	8.82
64	Insurance agents, brokers, and service	9	6.95
65	Real estate	6	9.09
67	Holding and other investment offices	5	11.38
70	Hotels, rooming houses, camps, and other lodging places	44	10.16
72	Personal services	1	9.68
73	Business services	265	8.03
75	Automotive repair, services, and parking	11	12.82
78	Motion pictures	2	8.28
79	Amusement and recreation services	16	11.75
80	Health services	3	10.64
82	Educational services	1	4.73
83	Social services	2	7.02
87	Engineering, accounting, research, management, and related services	45	7.85
89	Miscellaneous services	1	8.92
99	Non-classifiable establishments	73	12.54

Table 3

Summary statistics

This table presents the summary statistics for the dependent variable, Emissions (the natural logarithm of one plus a firm's total global gross scope 1 emissions), the independent variable (a country's uncertainty avoidance), and covariates in the model. The data constitutes a panel of firms between 2007 and 2018. Size is the natural logarithm of one plus a firm's market capitalization. BM is the book-to-market ratio. ROE is return on equity. Leverage is the ratio of debt to assets. Investment is the ratio of capital expenditures to assets. PPE is the natural logarithm of one plus property, plant, and equipment. Diversification is the natural logarithm of one plus the number of segments in which a firm operates. FDI is the value of net foreign direct investment inflows to a country as a share of GDP. Standard deviations depict within group variability, except for uncertainty avoidance. All financial variables are displayed in constant 2007 US dollars. Figures reflect winsorized distributions.

Panel A: Summary statistics – firm level

Variables	Observations	Mean	Std. Dev.	5th Percentile	95th Percentile
Emissions	4,356	11.0339	0.6263	5.7794	16.3816
Size	4,356	18.2020	0.2864	8.3848	24.3477
BM	4,356	0.1380	0.1029	0.0000	0.7539
ROE	4,356	0.0533	7.0821	-0.0866	0.4238
Leverage	4,356	0.2540	0.0601	0.0122	0.5264
Investment	4,356	0.0429	0.0147	0.0061	0.1029
PPE	4,356	7.5146	0.2509	4.6286	10.2646
Diversification	4,356	1.1229	0.0026	0.6931	1.7918

Panel B: Spearman correlations for firm-level characteristics

Variables	Size	BM	ROE	Leverage	Investment	PPE	Diversification
Emissions	0.129	0.238	-0.100	0.261	0.344	0.713	0.240
Size		-0.681	-0.083	-0.113	0.136	0.298	0.237
BM			-0.077	0.084	-0.099	0.252	-0.070
ROE				-0.023	0.025	-0.085	-0.123
Leverage					0.124	0.271	0.089
Investment						0.386	0.117
PPE							0.243

Panel C: Summary statistics – country level

Variables	Observations	Mean	Std. Dev.	5th Percentile	95th Percentile
Uncertainty avoidance	4,356	63.2245	21.9707	29	92
FDI	4,356	2.0361	6.2394	-0.2618	5.4755
GDP growth	4,356	1.6435	1.9785	-2.5368	4.1917
Globalization	4,356	4.4107	0.0774	4.2861	4.5097
Government effectiveness	4,356	1.4856	0.4460	0.3486	1.9842

Panel D: Spearman correlations for country-level characteristics

Variables	FDI	GDP growth	Globalization	Government effectiveness
Uncertainty avoidance	-0.383	-0.393	-0.363	-0.045
FDI		0.209	0.315	-0.250
GDP growth			0.032	-0.132
Globalization				0.213

Table 4

The relationship between GHG emissions and uncertainty avoidance

This table presents the results from regressions of total scope 1 emissions at a global level for a panel of firms between 2007 and 2018. All regressions feature year and industry fixed effects, with standard errors clustered at the firm level. Figures in parentheses are standard errors while bracketed figures are p-values.

	Dependent Variable = ln (Scope1Emissions)			
Independent Variables	(1)	(2)	(3)	(4)
Uncertainty avoidance	0.019 (0.004) [0.000]	0.022 (0.004) [0.000]	0.011 (0.003)	0.016 (0.004) [0.000]
Size		-0.104 (0.016) [0.000]		-0.094 (0.015) [0.000]
Book-to-market		0.026 (0.180) [0.886]		0.006 (0.177) [0.973]
Return on equity		-0.003 (0.001) [0.001]		-0.003 (0.001) [0.001]
Leverage		0.311 (0.353) [0.379]		-0.084 (0.359) [0.815]
Investment		2.583 (2.134) [0.227]		1.659 (2.068) [0.423]
PPE		0.962 (0.054) [0.000]		0.979 (0.052) [0.000]
Diversification		0.583 (0.164) [0.000]		0.530 (0.161) [0.001]
FDI			-0.021 (0.009) [0.022]	-0.014 (0.010) [0.183]
GDP growth			0.002 (0.026) [0.945]	0.018 (0.024) [0.458]
Globalization			-9.075 (1.073)	-4.237 (0.977)

			[0.000]	[0.000]
			0.389	-0.408
Government effectiveness			(0.179)	(0.167)
			[0.030]	[0.015]
	9.4964	3.4369	49.517	23.017
Constant	(0.254)	(0.437)	(4.623)	(4.314)
	[0.000]	[0.000]	[0.000]	[0.000]
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm
Adjusted R^2	0.027	0.424	0.091	0.459
Observations	5,015	4,351	4,988	4,351
Firms	1,396	1,145	1,369	1,145

Table 5

Carbon emission and uncertainty avoidance – Robustness checking

This table shows several estimations of firm-level GHG emissions on uncertainty avoidance and control variables, as well as industry and year fixed effects. The estimations feature standard errors clustered at the firm level. The sample is a panel of firms between 2007 and 2018. Figures in parentheses are standard errors while bracketed figures are p-values.

	Dependent Variable = ln (Scope1Emissions)			
Independent Variables	Alternative fixed effects	Non-U.S. Firms	Expanded specification	Post-Paris Agreement
	(1)	(2)	(3)	(4)
Uncertainty avoidance	0.017 (0.004) [0.000]	0.015 (0.004) [0.001]	0.020 (0.007) [0.003]	0.017 (0.004) [0.000]
Uncertainty avoidance*Post-Paris Agreement				-0.002 (0.003) [0.445]
Size	-0.096 (0.016) [0.000]	-0.089 (0.103) [0.390]	-0.146 (0.032) [0.000]	-0.095 (0.016) [0.000]
Book-to-market	-0.009 (0.203) [0.966]	-1.952 (2.467) [0.429]	-0.046 (0.180) [0.801]	0.004 (0.178) [0.981]
Return on equity	-0.003 (0.001) [0.004]	-0.004 (0.001) [0.001]	-0.002 (0.001) [0.003]	-0.003 (0.001) [0.001]
Leverage	-0.078 (0.378) [0.836]	-0.457 (0.560) [0.415]	-0.410 (0.362) [0.258]	-0.098 (0.361) [0.785]
Investment	1.449 (2.342) [0.536]	1.657 (2.677) [0.536]	1.234 (2.177) [0.571]	1.679 (2.068) [0.417]
PPE	0.982 (0.055) [0.000]	0.959 (0.107) [0.000]	1.047 (0.060) [0.000]	0.978 (0.052) [0.000]
Diversification	0.559 (0.166)	0.604 (0.196)	0.552 (0.159)	0.530 (0.161)

	[0.001]	[0.002]	[0.001]	[0.001]
FDI	-0.013 (0.011) [0.236]	-0.013 (0.010) [0.210]	-0.033 (0.015) [0.029]	-0.013 (0.010) [0.191]
GDP growth	0.022 (0.027) [0.415]	0.018 (0.025) [0.459]	0.014 (0.025) [0.592]	0.017 (0.025) [0.484]
Globalization	-4.248 (1.030) [0.000]	-4.259 (1.005) [0.000]	-4.689 (1.235) [0.000]	-4.221 (0.979) [0.000]
Government effectiveness	-0.407 (0.173) [0.019]	-0.432 (0.182) [0.018]	0.035 (0.293) [0.906]	-0.410 (0.168) [0.015]
Financial development			-0.004 (0.001) [0.002]	
Property rights			0.024 (0.014) [0.096]	
Internet users			-0.021 (0.008) [0.011]	
Constant	23.012 (4.549) [0.000]	23.426 (4.740) [0.000]	25.589 (5.405) [0.000]	22.963 (4.318) [0.000]
Industry FE	No	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes
Industry * Year FE	Yes	No	No	No
Cluster	Firm	Firm	Firm	Firm
Adjusted R^2	0.463	0.437	0.435	0.459
Observations	4,253	2,918	3,603	4,351
Firms	1,140	822	919	1,145

Table 6

Carbon emissions and uncertainty avoidance – Instrumental variable approach

This table shows the first and second stages of an instrumental variable procedure for the regression of firm's GHG emissions on uncertainty avoidance and control variables, including year and industry fixed effects. The instrument for uncertainty avoidance is genetic distance from Greece. The estimation is based on a sample of 4,349 observations (1,144 firms) and uses firm-level clustered standard errors. Figures in parenthesis are standard errors while bracketed figures are p-values.

	First stage	Second stage
Variables	Uncertainty Avoidance	ln (Scope1 Emissions)
Uncertainty avoidance		0.027 (0.007) [0.000]
Genetic distance from Greece	0.034 (0.002) [0.000]	
Size	0.854 (0.099) [0.000]	-0.113 (0.018) [0.000]
Book-to-market	0.746 (0.821) [0.363]	0.008 (0.178) [0.964]
Return on equity	-0.015 (0.005) [0.003]	-0.003 (0.001) [0.003]
Leverage	5.740 (2.477) [0.021]	-0.125 (0.359) [0.727]
Investment	-8.849 (13.308) [0.506]	1.838 (2.052) [0.370]
PPE	1.462 (0.332) [0.000]	0.964 (0.053) [0.000]
Diversification	2.534 (1.145)	0.475 (0.168)

	[0.027]	[0.004]
FDI	-0.103 (0.048) [0.030]	-0.012 (0.012) [0.261]
GDP growth	-2.635 (0.321) [0.000]	0.063 (0.034) [0.064]
Globalization	61.822 (12.774) [0.000]	-3.244 (1.080) [0.003]
Government effectiveness	-19.525 (2.223) [0.000]	-0.443 (0.169) [0.009]
Year FE	Yes	Yes
Industry FE	Yes	Yes
Cluster	Firm	Firm
Adjusted R^2	0.630	0.454
Observations	4,349	4,349
Firms	1,144	1,144
Underidentification Test		
Kleibergen-Paap rk LM statistic	61.31	
(p-value)	(0.00)	
Weak Identification Test		
Cragg-Donald Wald F statistics	1782	
Kleibergen-Paap Wald F statistic	95.80	

Table 7

Carbon emissions and uncertainty avoidance – Boundary conditions

This table shows the results from seemingly unrelated regressions between high and low subsamples along several channels for the estimation of firms' GHG emissions. The regressions utilize industry and year fixed effects, as well as standard errors clustered at the firm level. Chi-square statistics are for the comparison of uncertainty avoidance coefficients. Figures in parentheses are standard errors while bracketed figures are p-values.

	Dependent Variable = ln (Scope1 Emissions)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Economic decline (High)	Economic decline (Low)	External financing (High)	External financing (Low)	Societal instability (High)	Societal instability (Low)	Investment intensity (High)	Investment intensity (Low)
Uncertainty avoidance	0.000 (0.972) [0.951]	0.022 (0.008) [0.005]	0.016 (0.004) [0.000]	0.128 (0.034) [0.000]	-0.006 (0.008) [0.466]	0.016 (0.006) [0.010]	0.023 (0.005) [0.000]	0.012 (0.005) [0.018]
Size	-0.041 (0.032) [0.052]	-0.099 (0.021) [0.000]	-0.096 (0.016) [0.000]	-0.420 (0.119) [0.001]	0.005 (0.032) [0.873]	-0.113 (0.024) [0.000]	-0.103 (0.022) [0.000]	-0.089 (0.019) [0.000]
Book-to-market	0.114 (0.295) [0.701]	-0.040 (0.190) [0.835]	0.023 (0.224) [0.920]	-0.311 (0.227) [0.188]	0.167 (0.195) [0.392]	-0.077 (0.224) [0.735]	0.115 (0.319) [0.723]	0.002 (0.193) [0.991]
Return on equity	-0.003 (0.001) [0.386]	0.000 (0.004) [0.976]	-0.004 (0.001) [0.000]	0.026 (0.010) [0.014]	-0.011 (0.004) [0.010]	-0.003 (0.001) [0.001]	-0.003 (0.001) [0.000]	-0.001 (0.003) [0.628]
Leverage	0.081 (0.495) [0.798]	0.054 (0.426) [0.902]	-0.507 (0.406) [0.219]	0.471 (0.507) [0.370]	-0.001 (0.384) [0.998]	0.057 (0.465) [0.904]	-0.336 (0.501) [0.510]	0.365 (0.449) [0.426]
Investment	3.263 (2.420) [0.038]	1.651 (2.630) [0.537]	1.895 (2.309) [0.418]	-5.546 (2.766) [0.054]	1.437 (2.134) [0.512]	2.489 (2.739) [0.371]	-0.798 (2.507) [0.755]	13.450 (7.741) [0.089]
PPE	0.857 (0.071) [0.000]	1.014 (0.062) [0.000]	0.942 (0.058) [0.000]	1.416 (0.117) [0.000]	0.833 (0.081) [0.000]	1.029 (0.058) [0.000]	1.008 (0.072) [0.000]	0.919 (0.061) [0.000]
Diversification	0.485 (0.179) [0.000]	0.587 (0.205) [0.005]	0.547 (0.171) [0.002]	0.469 (0.256) [0.078]	0.482 (0.175) [0.007]	0.612 (0.194) [0.002]	0.576 (0.174) [0.001]	0.418 (0.216) [0.058]
FDI	-0.045 (0.016)	-0.007 (0.009)	-0.013 (0.010)	0.008 (0.027)	-0.016 (0.023)	-0.010 (0.009)	-0.014 (0.014)	-0.011 (0.012)

	[0.000]	[0.468]	[0.212]	[0.761]	[0.490]	[0.315]	[0.304]	[0.374]
GDP growth	0.039 (0.030) [0.106]	-0.073 (0.043) [0.094]	0.024 (0.026) [0.354]	-0.065 (0.081) [0.440]	0.112 (0.040) [0.006]	-0.074 (0.028) [0.010]	0.088 (0.039) [0.025]	-0.028 (0.032) [0.390]
Globalization	-3.840 (1.041) [0.000]	-2.145 (2.373) [0.375]	-4.224 (0.979) [0.000]	7.390 (5.361) [0.184]	-0.734 (1.249) [0.567]	-3.116 (1.995) [0.125]	-3.637 (1.235) [0.004]	-4.745 (1.264) [0.000]
Government effectiveness	-0.046 (0.181) [0.680]	-1.294 (0.375) [0.001]	-0.414 (0.172) [0.018]	-1.359 (0.461) [0.005]	-0.206 (0.215) [0.350]	-0.631 (0.433) [0.151]	-0.472 (0.207) [0.025]	-0.248 (0.233) [0.297]
Constant	22.660 (4.503) [0.000]	15.721 (10.641) [0.147]	24.611 (4.290) [0.000]	-26.473 (24.457) [0.209]	8.994 (5.356) [0.102]	19.3137 (9.178) [0.039]	21.633 (5.435) [0.000]	25.749 (5.522) [0.000]
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Adjusted R^2	0.677	0.705	0.673	0.790	0.689	0.703	0.698	0.659
Observations	1,848	2,508	3,210	1,146	1,580	2,776	2,171	2,185
Firms	665	833	1,072	365	703	857	688	706
Chi- square	4.90		10.63		4.92		2.88	
p-values	(0.027)		(0.001)		(0.027)		(0.090)	